U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-254 266

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PESTICIDES AND TOXIC SUBSTANCES
EFFECTS LABORATORY

1975

182079

PB 254 266

Potential Exposure of Workers to Parathion Through Contamination of Cigarettes

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During the last 15 years while conducting studies related to exposure of workers to pesticides we have observed the activities of literally hundreds of pesticide applicators and others who come in contact with toxic pesticides during their work day. A particular point which draws our interest is that very few seem to pay attention to any advice found on the pesticide container label concerning hazard from smoking when working with pesticides or smoking without first washing pesticide-contaminated hands. Precautions to this effect have been included in recommendations for safe pesticide use and on labels of highly toxic pesticides for many years. When confronted with the question, the usual answer from a worker reflects the idea that such precautions may be considered good advice but he doesn't feel that smoking while working with pesticides contributes much to his exposure; thus, he doesn't really consider such activity to be a significant hazard. As a result of these observations we have concluded that potential hazard from smoking pesticide-contaminated cigarettes has not been clearly defined.

Research on amount of residues of organophosphorus pesticides present in tobacco or tobacco smoke as a result of application to the growing crop has been carried out (HENGY and THIRION 1970; NESEMANN and SEEHOFER 1970); however, we are not aware of any published work related to potential exposure of spraymen or other workers from smoking cigarettes that have become contaminated with a toxic organophosphorus compound through handling by workers in the field or from pesticide drift during application.

When gloves are not worn the hands often become the most heavily contaminated body parts during pesticide application operations. This is probably at least partly due to the fact that they frequently come in direct contact with the more concentrated forms of pesticides during mixing and loading. The practice of smoking without washing hands, or smoking during pesticide application operations where there is potential for drift of pesticide onto an opened package of cigarettes carried in a shirt or coverall pocket, raises the question of the contribution of such contamination to the worker's total daily exposure.

Bulletin of Environmental Contaminaiton & Toxicology, Vol. 13, No. 3 © 1975 by Springer-Verlag New York Inc.

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The purpose of the present paper is to determine potential parathion contamination of cigarettes by spray drift, to determine contamination through contact with hands during pesticide application or fruit thinning activities, and to determine the effect of washing hands on cigarette contamination.

Materials and Methods

In order to arrive at some values that might be useful in estimating the potential health hazard from smoking parathion-contaminated cigarettes, both orchard spraymen and crop workers thinning apples were allowed to expose cigarettes under supervision during and following their normal work activities.

In the tests with orchard spraymen the operators of air-blast application equipment subjected test cigarettes to pesticide contamination through (1) carrying an open pack in the upper open coverall or shirt pocket during pesticide application operations, allowing exposure to spray drift for approximately 3 hours, (2) handling of individual cigarettes with hands contaminated with dilute and concentrate parathion, (3) smoking cigarettes to one-half their length while operating air-blast spray machines, (4) allowing cigarettes to become wet with dilute (0.03%) spray drift, (5) dropping them into dilute spray (resulting in maximum contamination possible with dilute spray), and (6) dropping them into 25% water-wettable powder. The only cigarettes actually smoked by the workers were those smoked to one-half their length while operating air-blast spray machines or during spray tank loading operations. This was under conditions of their normal practice; thus, they were not unnecessarily exposed for the purpose of the experiment.

In the tests involving apple thinners, potential exposure through cigarette contamination was estimated by analysis of cigarettes handled by individuals who hand-thinned apples in orchards sprayed 24 and 48 hours earlier with a 0.03% parathion solution using water-wettable powder formulation. After working for a period of 1 hour in two experiments and for a 5-hour forenoon in another, volunteer workers each smoked three cigarettes to half-length, leaving the remainder for analysis. Thus, the portions of the cigarettes analyzed were the parts receiving the most contact with unwashed hands. If workers were to completely smoke each cigarette, contamination would probably be slightly higher; however, it was felt that, under conditions of the present study, a major portion of the dislodgeable residue from fingers or other areas of the hands would be imparted to the cigarettes during the handling periods. These workers normally remained near the orchard during lunch time and it was their usual practice to leave hands unwashed before eating or smoking. During the noon-hour lunch period they usually smoked

two cigarettes from the time they left the work area in the orchard to the time they resumed thinning operations. Thus, by smoking three half-cigarettes their cigarette exposure was no more than normal.

Analysis of samples for parathion was by electron-capture gas liquid chromatography.

Results and Discussion

Results of tests involving contamination of cigarettes by spraymen during normal spray operations, or as a result of handling drums or measuring concentrate pesticide at loading of spray machines, are shown in Table 1. The greatest contamination of a cigarette during normal spray operations that did not involve noticeable contamination of hands with emulsifiable concentrate was found to be 18.1 μg. Hand contamination by contact with emulsifiable concentrate on the surface of drums, however, resulted in a maximum value of 235.6 μg of parathion imparted to a cigarette during handling and simulated smoking one-half the cigarette. Hands that appeared to be moist with either dilute spray or liquid emulsifiable concentrate material resulted in greater contamination of cigarettes than did hands which appeared dry.

Contamination of cigarettes with hands thoroughly washed with soap and water for 3 minutes following contact with 45.6% emulsifiable concentrate parathion during loading operations is shown in Table 2. These relatively low values can be compared with values in Table 1 for contamination of cigarettes with unwashed hands that had been in contact with the emulsifiable concentrate. Assuming that the hands before washing had been contaminated to the same degree as indicated in Table 1, washing was fairly effective but not enough to prevent cigarette contamination up to 1.2 μg during handling and smoking.

As can be seen in Table 3, the maximum spray drift contamination of cigarettes carried in the shirt pocket during spraying was only 2.3 μg. Maximum contamination of cigarettes fully exposed to conventional 0.03% dilute spray drift or thoroughly soaked in dilute spray solution was 37.3 μg. Cigarettes that were dropped into an opened bag of 25% water-wettable powder parathion, then recovered and brushed off by hand to remove excess pesticide, were contaminated with a maximum of 194 μg.

Data in Table 4 indicate that dry contaminated hands leave more parathion on the cigarette paper than in the tobacco, whereas, with moist hands slightly more penetrates through the paper into the tobacco. Penetration to the tobacco was 33.4% of the total contamination with dry hands and 55.6% with moist hands.

TABLE 1

Parathion Contamination of Cigarettes* by Spraymen

Condition	No. of cigarette exposures	Total contamination (μg/cigarette) Range	Average
HANDS CONTAMINATED DURING SPRAY APPLICATION OPERATIONS**			
1. Normal handling up to lighting of cigarette			
(a) dry hands	15	0.1 - 7.2	2.7
(b) moist hands	15	0.1 - 12.0	2.1
2. Normal handling through smoking one-half cigarette			
(a) while operating spray machine	36	4.1 - 18.1	9.1
(b) during wait while spray tank filling	21	0.1 - 4.5	2.2
HANDS CONTAMINATED BY HANDLING PESTICIDE DRUM			
1. Drum dry on outside			
(a) normal handling up to lighting of cigarette	12	42.3 - 76.7	57.9
(b) normal handling through simulated smoking one-half the cigarette	12	36.7 - 56.5	44.1
2. Drum moist with EC***on outside			
(a) normal handling up to lighting of cigarette	12	121.1 - 160.8	134.2
(b) normal handling through simulated smoking one-half the cigarette	12	115.0 - 235.6	178.7
HANDS CONTAMINATED WITH EC WHEN MEASURING PESTICIDE DURING LOADING OF SPRAY TANK			
1. Normal handling up to lighting of cigarette			
(a) dry hands	12	23.4 - 50.9	34.2
(b) moist hands	12	51.3 - 130.5	80.0
2. Normal handling through smoking one-half the cigarette			
(a) dry hands	12	28.9 - 48.5	37.0
(b) moist hands	12	63.9 - 123.1	90.4

*King-size filter cigarettes.
**Spraymen had been operating air-blast spray machines in orchards from 1-3 hours prior to tests.
***45.6% emulsifiable concentrate formulation.

TABLE 2

Contamination of Cigarettes with Hands Thoroughly Washed with Soap and Water for 3 Minutes Following Contact with 45.6% Emulsifiable Concentrate Parathion During Spray Rig Loading Operations*

Condition	No. of cigarette exposures	Total contamination (μg/cigarette) Range	Average
Normal handling up to lighting of cigarette	12	0.2 - 0.6	0.4
Normal handling through smoking one-half of cigarette	12	0.3 - 1.2	0.8

*Hands dried with towel after washings.

TABLE 3

Parathion Contamination of Cigarettes* by Controlled Exposures

Condition	No. of cigarette exposures	Total contamination (μg/cigarette) Range	Average
Open cigarette pack exposed by being carried in shirt pocket while operating spray machine (3 hrs)	18	1.5 - 2.3	1.9
Cigarettes thoroughly wet by 0.03% spray drift	12	12.1 - 15.3	13.9
Cigarettes soaked by dropping into 0.03% spray solution	12	17.4 - 37.3	28.5
Cigarettes dropped into bag of 25% WWP parathion and brushed off by hand to remove excess pesticide	12	29.9 - 194.0	108.9

*King-size filter cigarettes.

TABLE 4

Cigarette Surface Contamination vs. Penetration to the Tobacco During Normal Handling up to Lighting of Cigarette*

Condition	No. of cigarette exposures	μg Parathion per cigarette**			Percent of total in tobacco
		Paper	Tobacco	Total	
Dry hands	8	1.0	0.5	1.5	33.4
Moist hands	9	1.2	1.5	2.7	55.6

*hand contamination of king-size filter cigarettes from normal exposure to drift of 0.03% parathion spray during application operations.
**Average values.

Data in Table 5 show that spray drift conditions, as well as contamination of hands, can be a factor when workers smoke during operation of air-blast spray machines. In light drift conditions the average contamination value was 5.4 μg; in medium drift, 7.5 μg; and in heavy drift, 10.6 μg. The increased contamination of cigarettes from drift as wind velocity increases coincides with the earlier finding at this laboratory that wind is a factor in dermal and respiratory exposure of workers operating spray machines in orchards (WOLFE et al. 1967).

TABLE 5

Effect of Spray Drift as a Factor in Cigarette* Contamination with Parathion While Smoking During Operation of Spray Machine

Observed drift condition	Approximate wind velocity f.p.m.**	No. of cigarette exposures	μg/Cigarette	
			Range	Average
Light	10-20	18	3.6 - 8.2	5.4
Medium	75-100	18	6.5 - 8.9	7.5
Heavy	125-300	18	8.0 - 17.8	10.6

*King-size filter cigarettes.
**Feet per minute.

Contamination of cigarettes by orchard workers who had hand-thinned apples for a period of 1 hour in trees sprayed 24 hours earlier was found to range from 2.5 to 4.3 μg of parathion

per cigarette for 12 workers, with an average of 3.4 μg. In similar residues after working a 5-hour forenoon, contamination ranged from 3.8 to 5.2 μg with an average of 4.6 μg of parathion per cigarette for 6 workers. Following a 1-hour thinning period in 48-hour residues, contamination ranged from a value below the limit of the sensitivity of the chemical test to 5.5 μg with an average of 1.9 μg per cigarette for 9 workers.

Results of the present study indicate that potential exposure to parathion which might occur as a result of smoking during normal application operations, or during apple thinning, is not particularly high where contact is with dilute spray or foliage residues. When hands become contaminated with the more concentrated formulations, however, smoking without washing hands should be of more concern. The highest contamination value obtained in the present study was 235.6 μg per cigarette where contact was with emulsifiable concentrate material. If, in a 1-day work period, a worker smokes a pack of 20 cigarettes contaminated at this level, he theoretically would be taking in 4.7 mg of parathion per day which is above the 3 mg per day level EDSON (1957), as well as RIDER et al. (1958), found could be absorbed by a 60 kg adult without cholinesterase depression. However, it is doubtful that 20 cigarettes would be contaminated at that level during a work day. Also, this exposure is based on the assumption that all of the pesticide on a cigarette would be volatilized and drawn through the cigarette, and that none of the pesticide would be lost into the air, broken down by burning, or trapped in the butt end or filter of the cigarette. All of these factors are undoubtedly involved, so one would expect the amount of pesticide actually drawn through a cigarette to be considerably less than the total amount on and in the cigarette. Additional tests are being carried out to determine the amount of parathion or conversion products passing through a cigarette during smoking.

Even though the values obtained for potential exposure through smoking parathion-contaminated cigarettes may not appear to reflect any great hazard during most exposure situations, two important points must be kept in mind: (1) Pesticide entering by the respiratory-oral route is practically 100% absorbed, and (2) There is no assurance that a more toxic oxidation product, such as paraoxon, will not be formed and inhaled as the high temperature of a burning cigarette reaches the contaminated areas. Also to be considered is that such exposure is additive to what might already be relatively high exposure of the worker through the dermal route. Thus, a very important recommendation for pesticide applicators, and for

workers whose hands come in contact with parathion residues on crop foliage, should be to protect their hands from exposure as much as possible and to wash hands before smoking. Also, cigarettes should not be carried in open pockets where they may become exposed to spray drift.

Acknowledgment

We are grateful to Dorothy Fillman for technical assistance.

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